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COMPUTER COMMUNICATIONS AND DISSEMINATION OF ASWEP PRODUCTSTO T--ETC(U)
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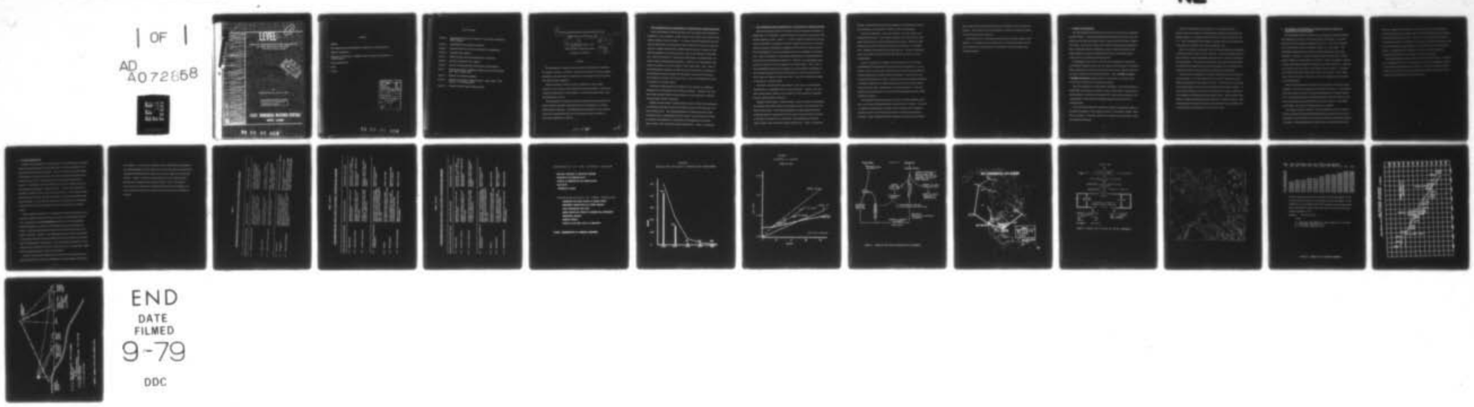

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COMPUTER COMMUNICATIONS AND DISSEMINATION OF ASWEP PRODUCTS TO THE FLEET NOW AND IN THE FUTURE

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By

CAPTAIN PAUL M. WOLFF, USN

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FLEET NUMERICAL WEATHER CENTRAL

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Computer Communications and Dissemination of ASWEP Products to the Fleet Now and in the Future

1964

By

Paul M. Wolff, Captain, USN

Fleet Numerical Weather Central

Monterey, California

27p.

Abstract

The advantages of computer communications are presented, indicating the speeds, accuracy, reliability, flexibility and capacity of these systems. Examples of size and types of communication computers are given and their cost effectiveness estimated.

Details are given of various modes of operations, such as data collection, their analysis and computation of derived products, computer-to-computer dissemination of gross products, further tailoring for users' need and distribution to users.

The possibilities and needs for direct computerized communications between the ships and shore computer facilities are emphasized, utilizing communication satellites. The flexibilities and properties of such communications are indicated and the use of the proposed system in ASW and other naval operations is outlined.

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1. THE CAPABILITIES AND ADVANTAGES OF COMPUTERS IN COMMUNICATIONS

Every environmental property has space and time scales which describe its distribution. As an example, a brief summary of the scales of sea surface temperature changes is given in Table 1. In order to analyze meaningfully and forecast the distribution of properties and their changes there must be a sufficient number of synoptic observations available and the density in space and time should correspond to the time and space scales of the changes of the properties. Some of the density of observation requirements are approximately fulfilled for some meteorological parameters. However, for oceanographic parameters this density is still too sparse in most ocean areas. Thus, many of the oceanographic analyses and forecasts must be derived by computation of the exchange processes between the atmosphere, where the driving forces of the ocean are located, and the sea itself. Thus the atmosphere and ocean are treated as a coupled system.

The timely communications and analysis of all synoptic environmental observations is a formidable task for manual operation. However, this task has become possible thanks to the availability of fast electronic computers and associated auxiliary equipment.

Besides the high speed in handling great volumes of data and computations, the computers also offer accuracy and reliability which is far above any subjective manual work. The computer approach also offers objectivity which eliminates personal interpretations which usually vary from worker to worker. At the same time flexibility is provided by wise programming of multiple choice criteria, thus eliminating human forgetfullness. Figure 1 summarizes

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the basic characteristics of numerical programs of environmental analyses and predictions as exemplified in FNWC systems and operations.

An array of computers, in fact any computer, can find a place in the environmental analysis. The smaller computers are usually used for high speed communication of data and checking and sorting. Medium to large computers are used for analyses and prediction purposes. In the latter case, extended core memories are usualy required. The list of computers used in the Naval Environmental Data Network and at FNWC is given in another paper.

Figure 2 illustrates the change in the time required for five million meteorological computations and the cost of these computations. As can be seen, low cost levels were achieved by 1967 after which the downward trends of speed and cost have slowed considerably. Figure 3 gives the computer cost summary for rented, purchased and lease purchase approaches. It should be noted that the computer lease prices and the lease purchase prices have gone down considerably in the last few years, so that computers are now accessible to any office where considerable amount of data handling is required.

The existing telecommunications via radio or teletype/telephone lines are in most cases overloaded and are very slow (50 to 120 wpm). Computer to computer communications via land lines or satellites has at present a speed of 4,000 to 8,000 wpm and can reach 25,000 wpm with existing hardware. Small computers and other inexpensive communication devices

(many of which have been designed and built at FNWC) can be used for this purpose. With certain technical precautions, computer to computer communications are practically error free.

The overall cost of a computerized communication network might be high, however, it is shared by many users and thus by pooling resources, the cost per unit amount of communication is considerably lower than present conventional systems.

2. MODES OF OPERATIONS

The meteorological observations are received via the Air Force Automated Weather Network. Remote observations from European and Asiatic areas are received at Air Force facilities in Fuchu, Japan and High Wycombe, England. From there, they are fed to Tinker Air Force Base where western hemisphere data is added and then the information is sent to Monterey through a high speed computer to computer communication line with the present speed ranging from 4 to 8 thousand words per minute.

Oceanographic data mainly in the form of BT messages are received at Fleet Weather Centrals and are fed via computer communications to Monterey. Small computers are used for sorting of the data and error checking and then the data are used for environmental analyses. After their use in synoptic analyses, the data are usually stored in a packed form on magnetic tape and are later utilized for climatological analyses.

After the completion of the analyses at Monterey, the analyzed fields are transmitted via computer to computer in form of band indexes, transmitted to tieline stations via collect and transmit (CAT units) directly plotted on Cal Comp plotters, or distributed by teletype messages extracted from the analysed fields.

The environmental data are converted to operational parameters partly in Monterey and partly at other computer centers, such as Rota, Norfolk, Pearl Harbor and Guam. From these stations the products are transmitted to ships via teletype or facsimile.

This Navy Environmental Data Network is illustrated on Figure 5. Figure 6 gives the schemes of data processing analyses and dissemination. Whereas Figure 1 is a general scheme of data flow, figure 6 describes the U. S. Navy Environmental Data Network in greater detail giving indications of the types of computers and auxiliary equipment used.

There is no specific requirement that the computer products be forwarded to the fleet as they come out of the computers. Many of the forecasting programs are still in the developmental stage and have a number of limitations and shortcomings. Thus manual interventions and corrections are possible, provided that the properties of the existing program and its possible shortcomings are known by those making the modifications subjectively.

One of the main advantages in computer communications and dissemination of the data is the high speed and big volumes of data which can be rapidly transmitted from one place to another, circumventing the low speed, saturated teletype circuits and other outmoded communication systems. In case of major conflicts some parts of the computer to computer communication systems are vulnerable and other parts are safe. There are some limitations to sending classified data from computer to computer; however, most of the synoptic environmental analyses and forecasts are unclassified due to the rapid rate of deterioration of the data with time.

3. TAILORING OF THE PRODUCTS, FEEDBACK FROM THE USERS AND EVALUATION OF THE FORECASTS

The operational products derived from environmental analyses/forecasts and forwarded to the ships, are tailored either in Monterey or in weather centrals to fit the particular requirement of the user. One of the essential types of tailoring is done with respect to space and time scales. The hemispheric analyses may be useful for certain purposes in large scale operations. However, in small scale operations and especially in oceanographic subjects a zoomed product is desired. Figure 7 illustrates a zoomed synoptic sea surface temperature analysis of the Grand Banks area. Although this analysis may be accurate at the specific time it refers to, it contains many details which may change over a short period of time. Thus, before such a chart is forecast on facsimile it might be generalized and smoothed to a certain degree.

Many of the analyses and forecasts are disseminated in the form of area messages. One of these messages is illustrated on Figure 8. This message allows the analyses of three environmental parameters to a general degree. First, the numerical values of the parameters (SST, MLD and WH) are given only at half degree latitude/longitude intersections (ca 30 n. miles apart) and secondly, the values of the parameters are truncated.

Any complex system is doomed to become obsolete in time if it does not include a learning and improving process. Through verification and tuning of the product such a process is built into the numerical environmental forecasting system. Good opportunities for verification are provided during Naval

exercises, operations and transits or when many ships are concentrated in relatively small areas and those ships are making observations and comparing them with the forecasts provided. When such verifications are sent back to the forecasting centers, analyses of the causes and nature of the errors can be made and corresponding improvement can be incorporated into the numerical models. An example of the verification of an outlook which was given several weeks ahead of a given transit is shown on Figure 9.

Besides the personal communications of messages and letters, it has been found profitable for the users to make periodic visits to the Weather Centrals to learn about the properties and limitations of different forecasting models as well as the need to observe and report back specific data which are most needed for improving particular forecast models.

4. FUTURE PERSPECTIVES

A number of improvements in communications and dissemination of environmental analyses/forecasts and their application in tactical problems can be achieved with the available hardware. The first and most promising of these improvements is the more general use of satellite communications from ship to ship and vice versa. The communications systems are illustrated in Figure 10. As economic and other reasons will limit the capabilities of the communications equipment on smaller vessels, it seems to be desirable to designate a number of larger vessels as relay stations. These larger vessels should be able to receive the data via satellite using high speed small shipboard computers, In turn they can disseminate the forecasts to surrounding vessels and receive their observations for rapid transmission to analysis centers.

Another natural development in oceanographic analysis/forecasting is the creation of broader international bases for synoptic oceanographic observations, hemispheric analyses and further application of the oceanographic analyses/forecasts in economical undertakings such as fishing and ship routing. This internationalization would allow considerable savings to all nations concerned. However, this reorganization would require the overhaul of the present relatively outmoded WMO communication network to accommodate the oceanographic observations. The interpretation and tailoring of the product for the particular users must obviously remain a "closed-shop" operation for national fisheries as well as for the Navy.

There is a great need for officers in the Navy as well as fisheries to be specially educated in synoptic oceanography and oceanographic predictions

and analyses. It is often not sufficient to have specialized meteorologists and oceanographers to do their work but the particular users must have some background knowledge of the subject he is trying to apply to his particular problem. Finally it should be noticed that many of the communications problems are vulnerable during a major conflict. Thus, the operating forces must be in possession of extended forecasts and climatology to be used at the initial stage of the conflict when communication breakdown is expected.

TABLE 1

APPROXIMATE AREA AND TIME SCALES OF SEA SURFACE TEMPERATURE (SST) CHANGES

Processes affecting SST change		Approximate area scales	Approximate time scales
1.1	Permanent (gradient) flow	Usually in oceanwide scale and in form of gyrals, 500 to several thousand km. in diameter. Small off estuaries and modified near continental shelf.	Seasonal, except near current boundaries and the coastal waters where dependent on insolation and runoff.
1.2	Wind currents	Gyrals correspond to the sizes of cyclones and anticyclones.	Cyclone belt - 2 to 8 days Anticyclone belt - 6 to 14 days
1.3	Inertia and tidal currents	Size of the amphidromic tidal systems. Smaller in semi-closed bays.	Tidal, diurnal, or semidiurnal. Inertia currents dependent on latitudes, (avg. 30 hr.).
2.1	Insolation	Greatly determined by latitude and cloudiness patterns; in general 1/2 cyclone and 1/4 anticyclone size	Seasonal and synoptic (see 1.2 above)
2.2	Evaporation	More rapidly changing smaller patterns in tropical storms, at coasts	Mainly seasonal; synoptic periods as 1.2 above.
2.3	Other heat exchange	and occasionally at sharp current boundaries.	Seasonal and synoptic as 1.2 above. The synoptic periods also vary seasonally, especially at low latitudes.

TABLE 1 (cont'd)

APPROXIMATE AREA AND TIME SCALES OF SEA SURFACE TEMPERATURE (SST) CHANGES

Processes affecting SST change		Approximate area scales	Approximate time scales
3.1	Wave action	Generally the size of cyclones and their wind fields.	Cyclone belt - 2 to 8 days Anti-cyclone belt - 6 to 14 days.
3.2	Convective stirring	Generally latitudinal pattern; at the periphery of cyclones (about 1/2 of their size).	Mainly seasonal in medium and high latitudes
3.3	Currents (mixing by)	Usually important near major current boundaries. Scale from a few miles to a few hundred miles.	Seasonal, except near current boundaries and in coastal waters.
4.1	Upwelling and divergence/ convergence	Usually narrow and elongated areas near coasts, oceanic and atmospheric fronts; from tens to hundreds of miles wide, several hundred to thousands of miles long.	Seasonal and synoptic (see 3.1 above)
4.2	Runoff	Off estuaries and along the coast; few miles to a few hundred miles wide.	Mainly seasonal
4.3	Precipitation	Of minor importance only in high latitudes during the winter; the size of precipitation (snow) area.	Seasonal and synoptic (see 3.1 above)
4.4	Freezing and melting	Important only near coasts and near ice boundaries.	Mainly seasonal

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A T T R I B U T E S   O F   A N Y   S U P P O R T   S Y S T E M

REALISTIC SOLUTIONS TO PREDICTION PROBLEMS

OBJECTIVITY AND REPRODUCIBILITY

RAPIDITY OF COMPUTATIONS AND COMMUNICATIONS

RELIABILITY

RESPONSIVE TO USERS

C H A R A C T E R I S T I C S   O F   F N W C   P R O G R A M S

ATMOSPHERE AND OCEANS TREATED AS COUPLED SYSTEM

HEMISPHERIC COMPUTATIONS PLUS ZOOMED PRODUCTS

FULLY COMPUTERIZED DATA CYCLE

MODELS EMPIRICALLY TUNABLE TO RESEMBLE REAL ENVIRONMENT

ENGINEERING APPROACH

COMPLETE SUPPORT

OUTPUTS IN ANY FORM, SCALE, OR PROJECTION

FIGURE 1 CHARACTERISITCS OF NUMERICAL PROGRAMMES

FIGURE 2

TIME AND COST OF 5 MILLION METEOROLOGICAL COMPUTATIONS

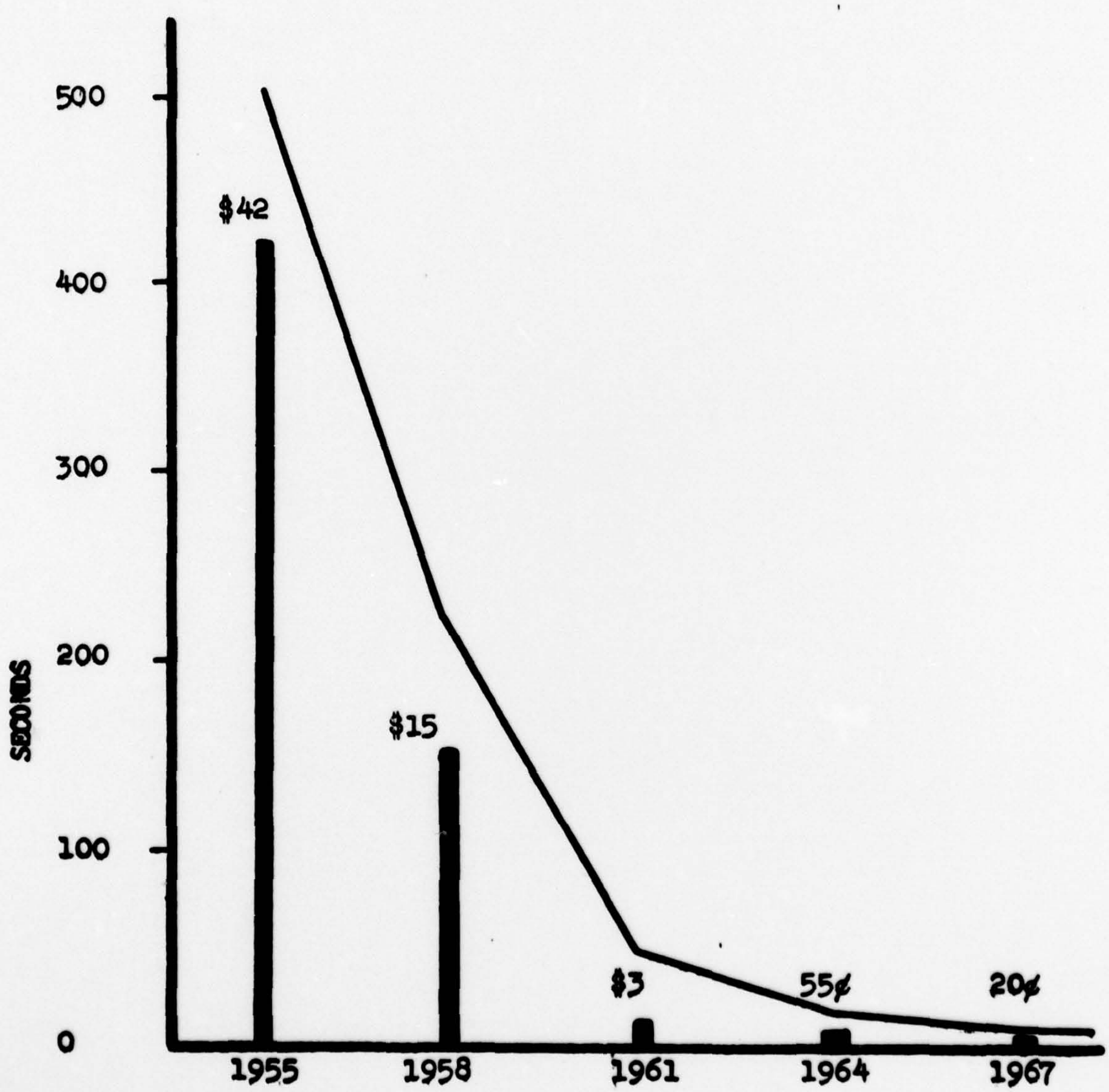
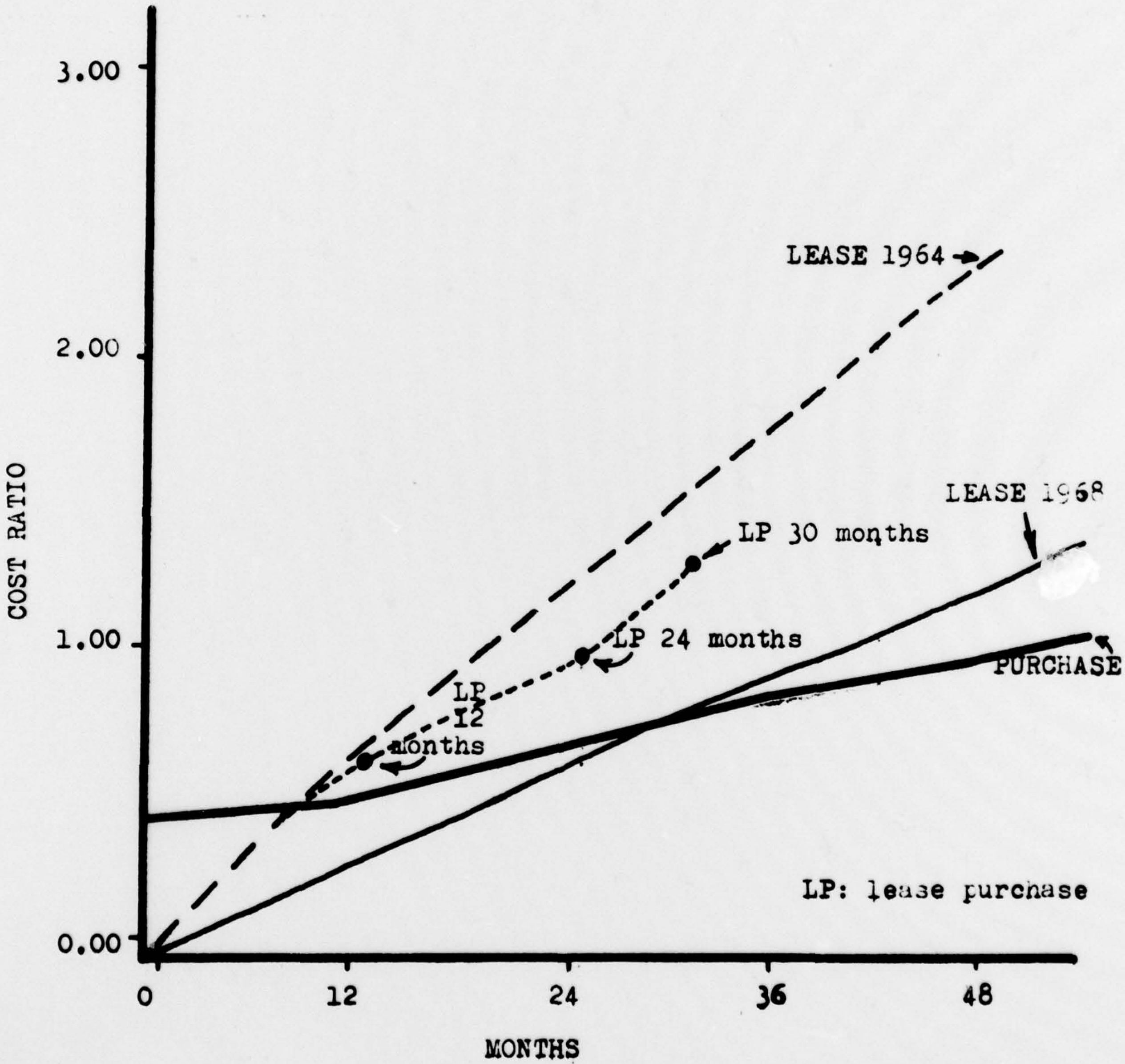


FIGURE 3

COMMPUTER COST SUMMARY

THREE SHIFTS



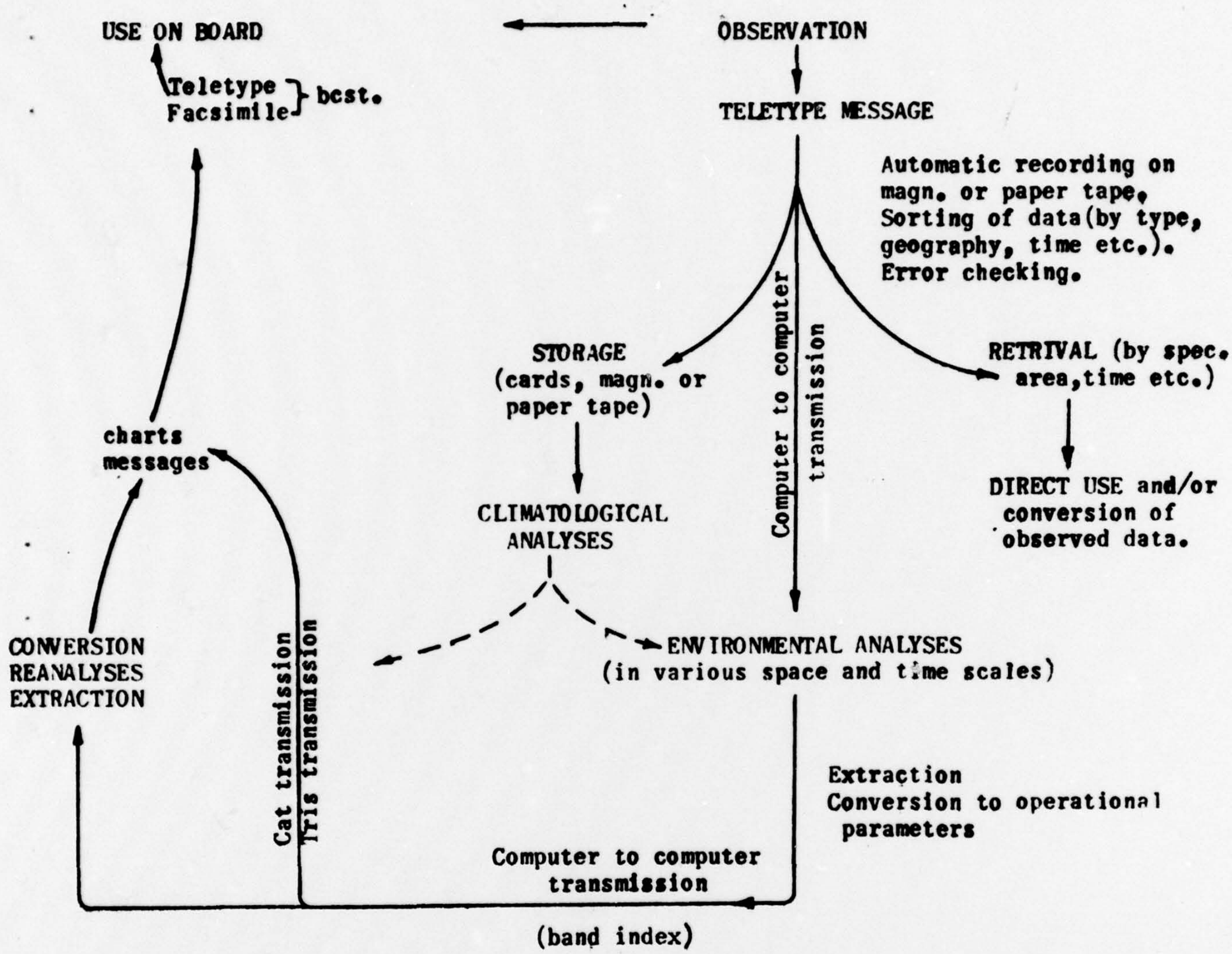
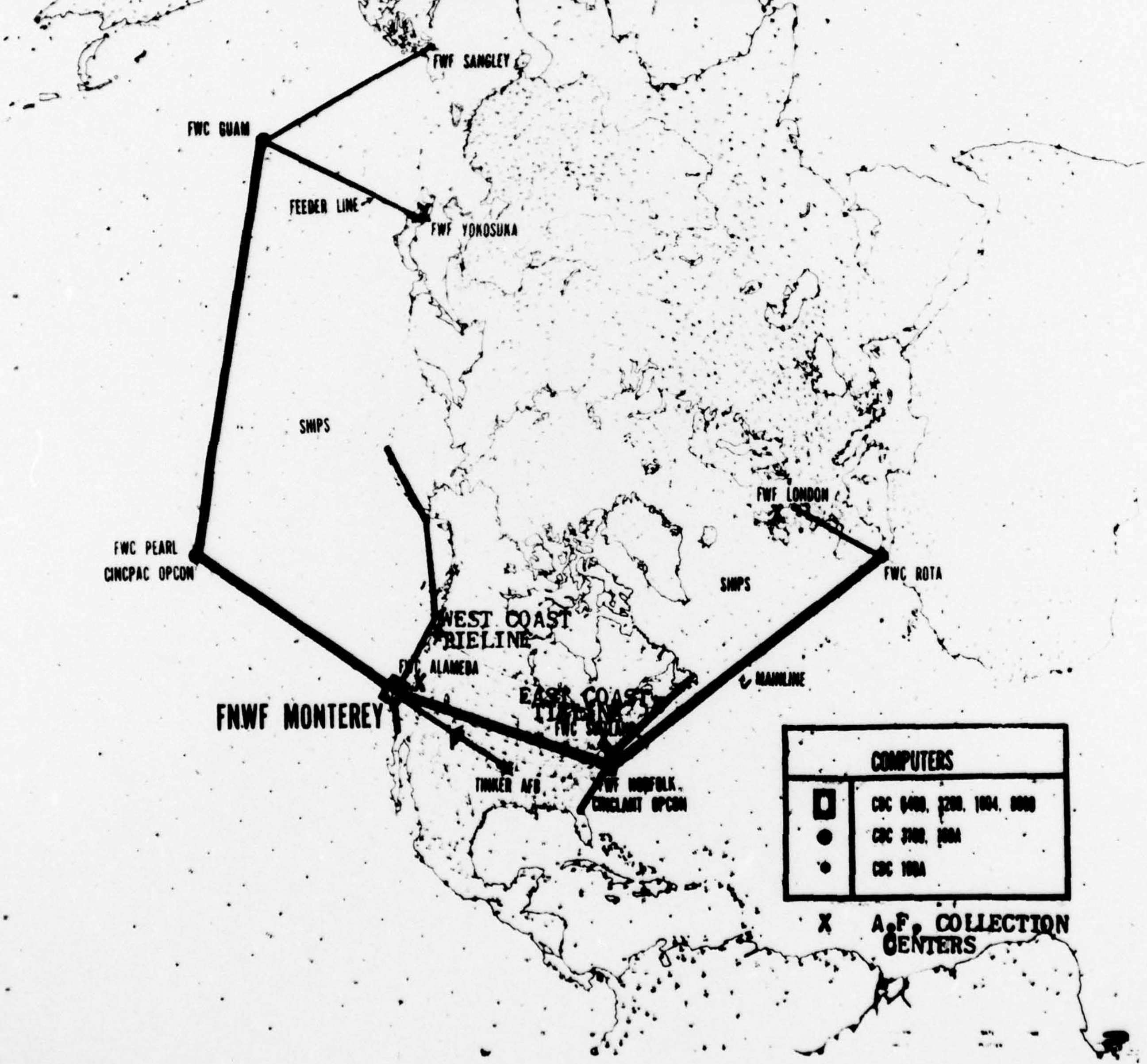


Figure 4. Scheme of data flow and dissemination of products.

FIGURE 5

NAVY ENVIRONMENTAL DATA NETWORK



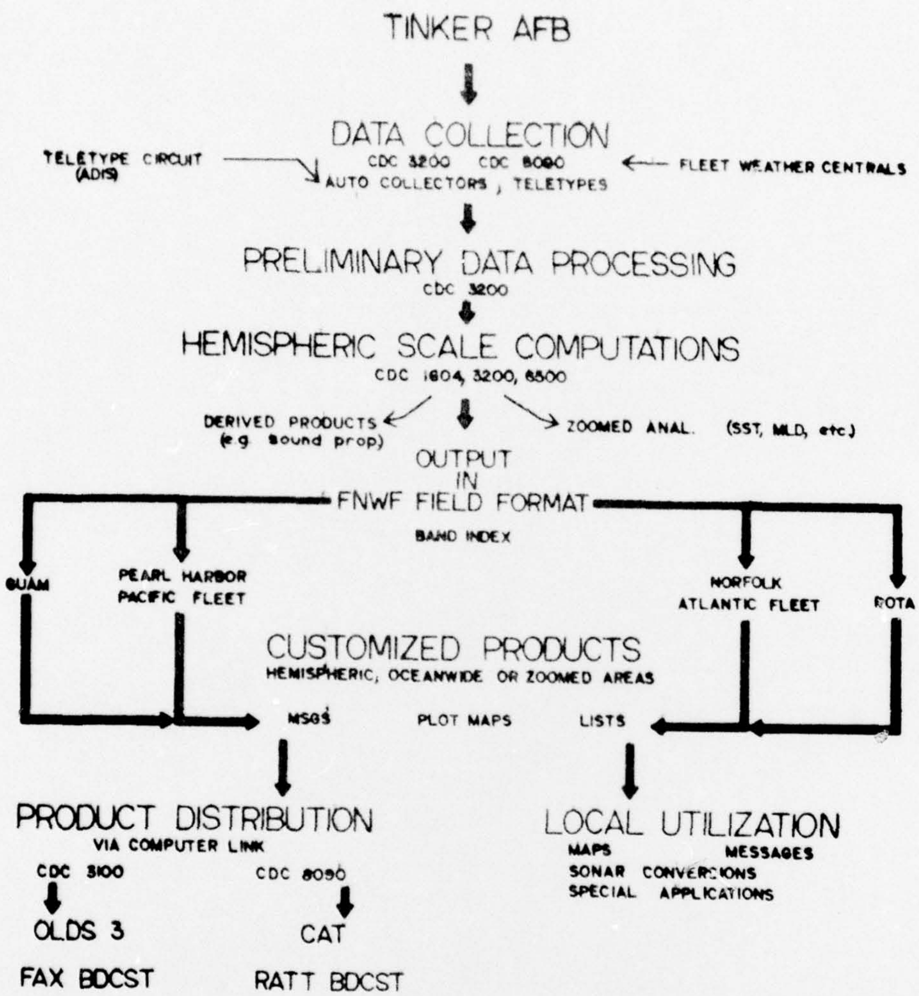


FIGURE 6 SCHEME OF DATA PROCESSING AND ANALYSES DISSEMINATION

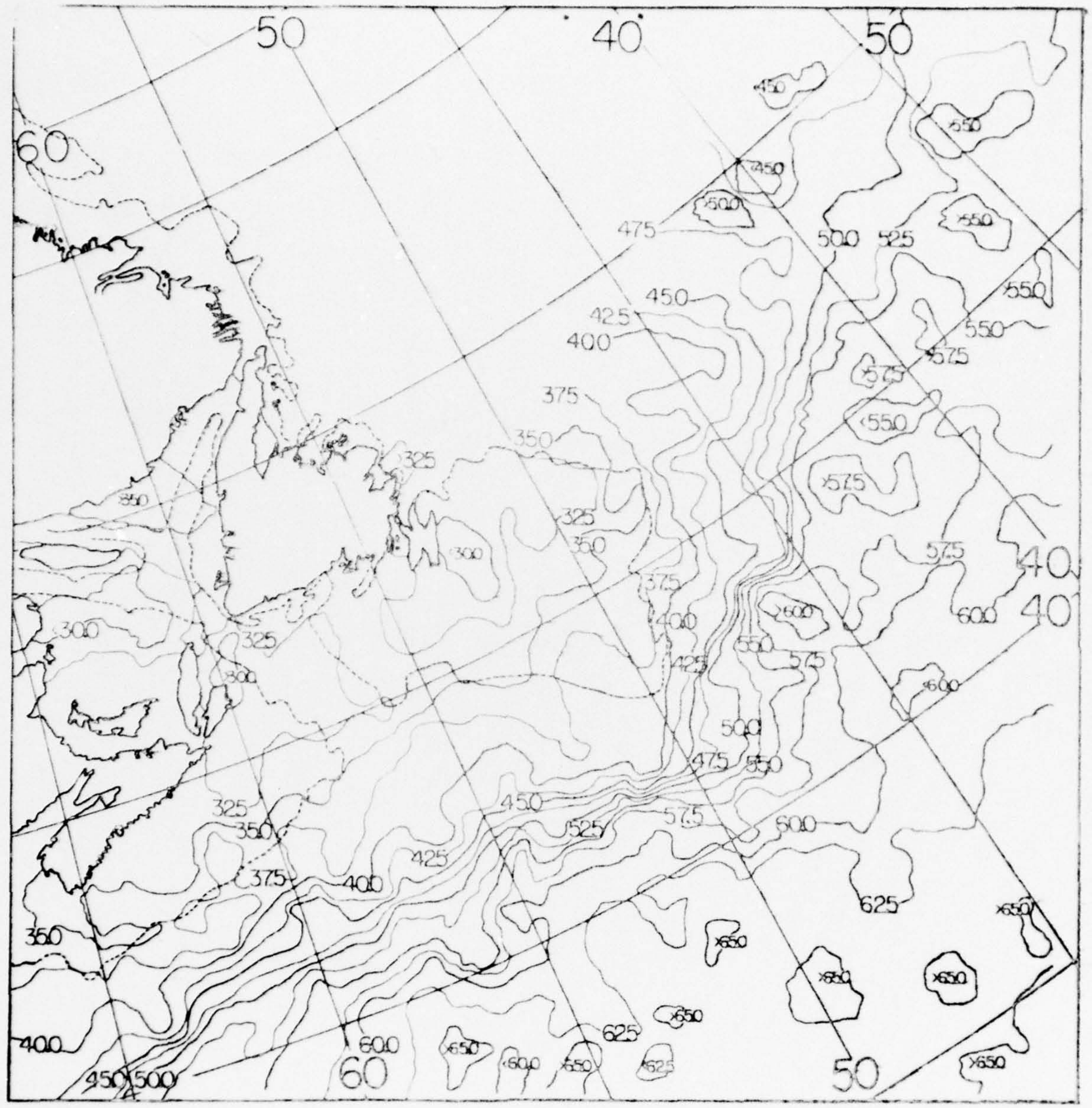


FIG. 7 SYNOPTIC SEA SURFACE TEMPERATURE ANALYSIS OF THE GRAND BANKS AREA
OOZ, 17 MARCH 1967

VCAP SEA 24 HR PROG FROM 00Z 19 FEB 66 SEA ENVIRON

N	75.0	74.5	74.0	73.5	73.0	72.5	72.0	71.5	71.0	70.5	70.0
420										20335	32035
415									32136	33436	33436
410							31838	33337	33537	33337	33337
405						33541	33540	33439	33438	33339	33339
400				23943	23743	33543	33442	33442	33442	33342	33342
395		21045	23844	23544	33544	33543	33444	33444	33444	33345	33346
390	20845	22744	23743	33544	33544	33544	33444	33545	33446	33447	33448
385	21846	23844	33544	33544	33444	33443	33445	33447	33348	33250	33252
380	22646	33646	33446	33346	33346	33345	33347	33249	33251	33253	33151
375	33647	33346	33247	33249	33250	33251	33152	33153	33154	33055	33053
370	33148	33147	33150	33053	33055	33056	32956	32956	32956	32958	32960
365	33053	32952	32955	32857	32859	32860	32860	32860	32860	32861	32863

The first vertical column gives N latitude for every half degree and the second horizontal line gives W longitude for every half degree. At the intersection of corresponding latitudes-longitudes the five figure group gives sea height (in code), mixed layer depth in tens of feet and sea surface temperature in $^{\circ}F$.

Example: 39.0 N 074.5 PW

22744

2 - sea height code (WMO 75), wave height 1/3 to 1-2/3 feet
27 - mixed layer depth 270 feet
44 - sea surface temperature 44°F

FIGURE 8. EXAMPLE OF A FORECAST MESSAGE

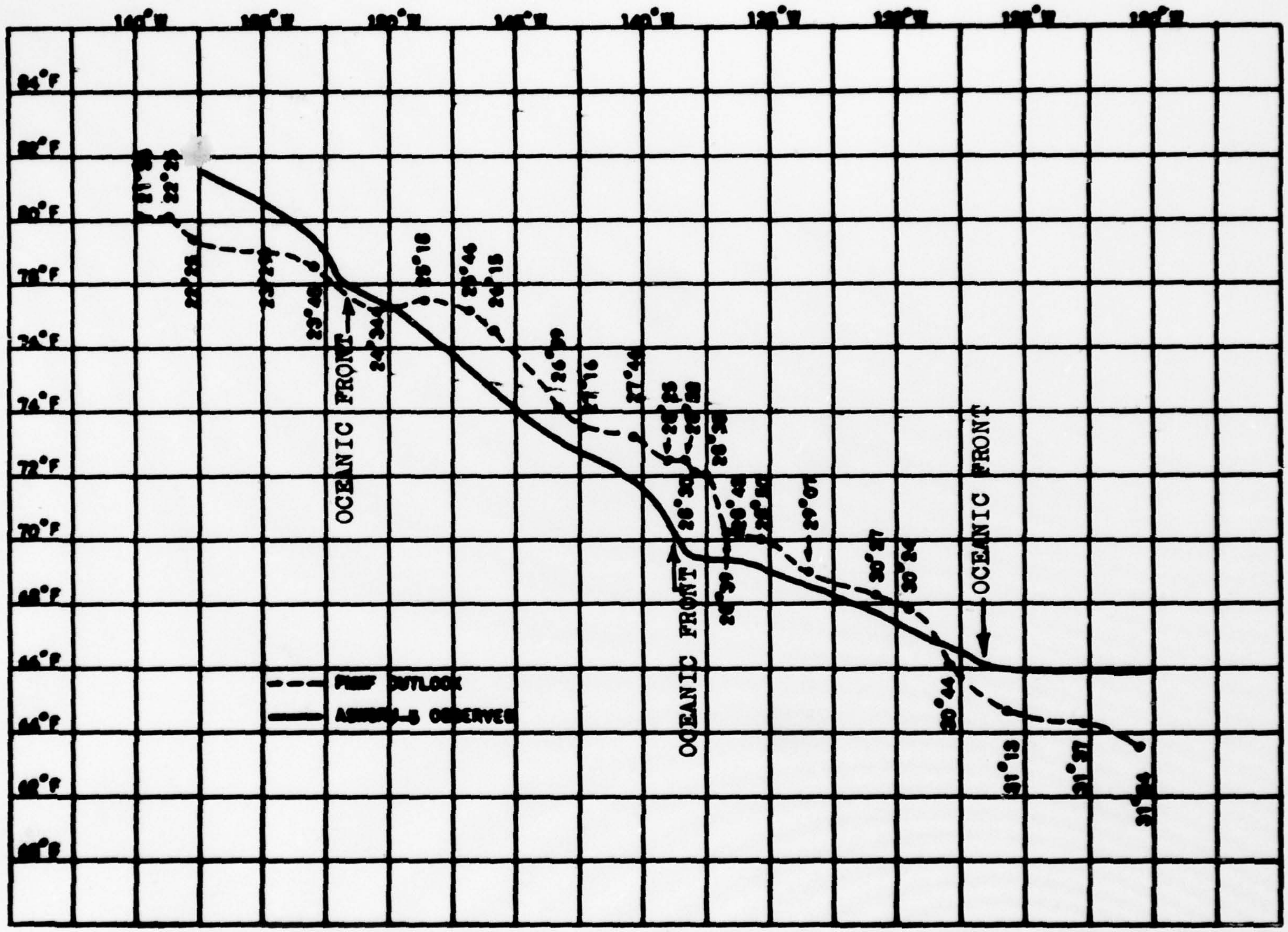


FIGURE 9 Observed sea surface temperatures versus FNWC outlook SST 17-26 Aug. 1967

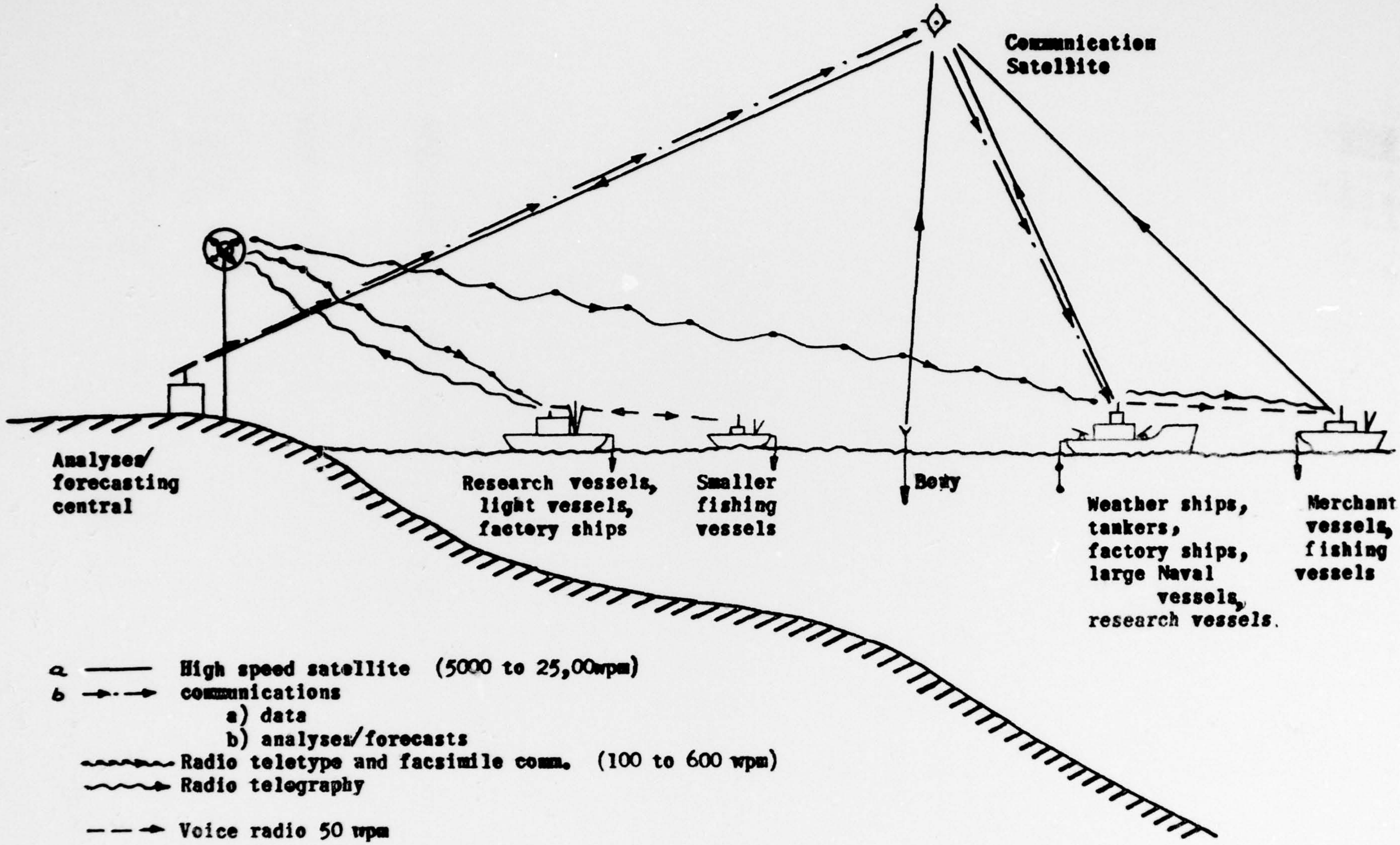


FIGURE 10 Scheme of ship to shore communications.